



COMMERCIALIZATION AND THE SMALL BUSINESS  
INNOVATION RESEARCH PROGRAM (SBIR):  
AN EXAMINATION OF THE IMPACTS OF  
COMMERCIALIZATION ON THE SMALL BUSINESSES'  
ABILITY TO PROVIDE RESEARCH AND DEVELOPMENT  
INNOVATION TO THE DEPARTMENT OF DEFENSE

THESIS

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AFIT/GCM/LAS/96S-7

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Jennifer J. Thorpe

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Abstract

This research explored the small business's perceived ability to provide goods and services to the Department of Defense through the Small Business Innovation Research (SBIR) program. The research was sparked by the enactment of Public Law 102-564, which increased the emphasis in commercialization as a basis for contract award and required a business plan to demonstrate commercial potential and third-party funding commitments. Five SBIR participants in the acquisition of Air Force research and developments innovation, were investigated through case-study methodology. The research concluded that although the defense industries recognized the cumbersome nature of government procurement, they are eager to provide recommendations that may enhance the effectiveness of the program. The research findings also suggested that the Government periodically solicit the perceptions of small business participants prior to making policy changes to ensure the impact of those changes is not contrary to the intent of the program. Finally, the research uncovered issues that impact small business participation in the program. Additional research into these issues may further improve the efficacy of the SBIR program which promotes technology transfer through the use of small businesses.

# COMMERCIALIZATION AND THE SMALL BUSINESS INNOVATION RESEARCH

## PROGRAM (SBIR):

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DEVELOPMENT INNOVATION TO THE DEPARTMENT OF DEFENSE

### I. Introduction

Small businesses have demonstrated they can be an effective medium for developing and commercializing innovations. Studies by D. L. Birch (Birch, 1987), J. O. Flender and R. S. Morse (Flender and Morse, 1977) and R. Rothwell and W. Wegveld (Rothwell and Wegveld, 1982) have documented this efficacy. Further, the Department of Defense has been directed to provide technical assistance to small businesses to ensure the process of providing this service is less burdensome. Despite this assistance, some studies have suggested less than desirable outcomes are sometimes realized (Masten and Hatmann, 1993). These studies report that some laboratories perceive the interaction with small businesses as difficult and less rewarding. R. K. Carr suggests that the fundamental problem in working with small businesses is that they are under-

informed about the existence of opportunities and how to gain access to them (Carr, 1992). According to X. Greffe and J. M. Pennings, programs are needed which encourage small businesses to develop innovations for commercialization.

One such program is the Small Business Innovation Research (SBIR) Program, established by the Small Business Innovation Development Act of 1982. The program was established to "encourage innovation by requiring the Federal agencies to award a portion of their research funds to small business through special research programs" (GAO, 1987:2). Additionally, the Act directs the Small Business Administration to impose policy directives on each participating Federal agency that are less burdensome to the small businesses. These policies provide guidance for "minimizing the regulatory burdens associated with participating in the SBIR program" (P.L. 97-219, Section 4).

Although the SBIR Program has been reporting success in meeting its objectives, reports have begun to focus, more specifically, on the efficacy of the SBIR Program in meeting Federal commercialization goals. Public Law 102-564 amended the SBIR Program to place more emphasis on the commercialization potential. Consequently, small business proposals are evaluated on, among other things, "the proposal's commercial potential" (P.L.102-564, Section 103).



Specifically, small businesses are evaluated on their ability to demonstrate a potential commercial application for their innovations, including potential non-SBIR funding sources. This new emphasis may force small businesses to focus their efforts on improvements to current technology rather than inventing new technology to solve current problems. Their focus may shift from exploring innovations through basic research to developing engineering solutions for current constraints.

#### **Purpose of the Research**

The Air Force Small Business Innovation Research Program Executive Office sponsored this research. It is interested in finding out how the new emphasis on commercialization affects the perceptions held by small business participants. Specifically, it wanted to investigate small business's perceived ability to provide goods and services to the Department of Defense through the SBIR program. This research focuses on SBIR participants who submit proposals and perform under contract to the Department of the Air Force.

#### **Background**

A study of problems and barriers to small business participation in the sale of goods and services to the

United States Government suggests the existence of barriers to entry which limit participation of small business in this important market (Cosmos, 1986). These barriers include complicated Federal procurement regulations, excessive paperwork resulting from these regulations, difficulty in obtaining access to information, short turnaround times for bids, unclear or excessively complicated specifications, and problems stemming from the perspective contractor's resource and/or cash flow limitations. The resulting findings emphasize the difficulties faced by small firms who conduct business with the Federal Government. Additionally, the study emphasizes several areas where current legislation is making the SBIR program more cumbersome and insensitive to the circumstances faced by the firms targeted by the program itself.

Table 1 provides a summary of the Federal legislation designed to stimulate small business participation in the Federal marketplace (Cantor, 1989). For the purpose of this research, the most relevant piece of legislation is the Small Business Innovation Development Act of 1982. This Act established the Small Business Innovation Research Program, which intended to strengthen the role of small innovative companies in federally-funded research and development (SBA, 1992). This Act is primarily used to provide funding

assistance to small firms while generating a solution to a Government problem.

TABLE 1

FEDERAL LEGISLATION: SMALL BUSINESS PARTICIPATION IN THE  
FEDERAL MARKETPLACE

ACT	DATE ENACTED	TARGET PROBLEM/BARRIER
Defense Procurement Reform Act	1984	Introduces more competition into Department of Defense procurement
Small Business and Federal Procurement Enhancement Act	1984	Introduces more competition into Department of Defense procurement
Commerce Business Daily Act	1983	Mandates that all Federal procurements be advertised prior to contacting
Small Business Innovation Development Act	1982	Mandates increasing percentage of research and development procurement go to small business
Prompt Payment Act	1982	Mandates timelines for Federal contracting agency bill payments
Certificate of Competency Program	1982	Provides a method for pre-auditing firms for procurement acceptability

TABLE 1 (con't)

ACT	DATE ENACTED	TARGET PROBLEM/BARRIER
Small Business Administration Office of Advocacy	1979	Provides an advocate within the Government for small businesses to use for problem resolution
Small Business Subcontract Act	1979	Requires Federal contractor to subcontract portion of work to small business

Congress based its design of the SBIR program on three assumptions/observations. In 1982, it found that (1) technological innovation creates jobs, increases productivity, competition, and economic growth, and is a valuable counter-force to inflation and the United States balance-of-payments deficit, (2) while small business is the principal source of significant innovation in the nation, the vast majority of federally-funded research and development is conducted by large businesses, universities, and Government laboratories; and (3) small businesses are among the most cost-effective performers of research and development and are particularly capable of developing research and development results into new products.

As a result, Congress drafted SBIR to:

(1) stimulate technological innovation, (2) use small business to meet Federal research and development needs, (3) foster and encourage participation by minority and disadvantaged persons in technological

innovation, and (4) increase private sector commercialization innovations derived from Federal research and development. (P. L. 97-219)

The SBIR program consists of three phases. The first phase determines the scientific and technical merit and feasibility of ideas submitted pursuant to the SBIR solicitation. The second phase further develops the proposed ideas to meet the particular program needs. The awarding of the contract takes into consideration the scientific and technical merits and feasibility evidenced by the first phase when two or more proposals are evaluated as being equal. Special consideration is given to those proposals that have demonstrated third phase, non-Federal capital commitments. The last and third phase involves pursuing commercial applications of the research. It also involves follow-on non-SBIR funding production contracts with a Federal agency for products or processes intended for use by the United States Government.

After experiencing some success with the implementation of the Act, in 1986 Congress extended the provisions of the Act through 1993. Congress further amended the SBIR program to reflect the impact of its recent findings as communicated through mandated reports and surveys conducted by the Comptroller General.

In Public law 102-564, Congress concluded the SBIR program: (1) had been a successful method of involving small

business concerns in Federal research and development; (2) had been an effective catalyst for the development of technological innovations by small business concerns; (3) participants had provided high quality research and development in a cost-effective manner; (4) had effectively stimulated the commercialization of technology developed through Federal research and development, benefiting both the public and private sectors of the Nation; and, (5) had helped to increase exports from small business concerns.

Additionally, Congress found:

- (1) the innovative products and services had been important to the national defense;
- (2) technological innovations, the SBIR program had created jobs, expanded business opportunities for small firms, stimulated the development of new products and services, and improved competitiveness of the Nation's high technology industries;
- (3) despite general success of the SBIR program, there had not been an increase in funds received by small business concerns over the life of the program; and
- (4) additional outreach was necessary to stimulate increased participation of socially- and economically-disadvantaged small business concerns.

As a result of these findings, P. L. 102-564 was drafted to: (1) expand and improve the small business innovation research program; (2) emphasize the program's goal of increasing private sector commercialization of technology developed through Federal research and development; (3) increase small business participation in

Federal research and development; and, (4) improve the Federal Government's dissemination of information concerning the small business innovation research program, particularly with regards to program participation by women-owned small business concerns and by socially- and economically-disadvantaged small business concerns (P. L. 102-564).

Additionally, the Act emphasized commercialization as an evaluation criteria for phase two projects. It states that "awards shall be made based on the scientific and technical merit and feasibility of the proposals, as evidenced by the first phase, considering, among other things, the proposal's commercialization potential" (P. L. 102-564:2). Small businesses can demonstrate commercialization potential by providing a record of: (1) successful commercialization of SBIR or other research; (2) second phase funding commitments from private sector or non-SBIR funding sources; (3) third phase, follow-on commitments for the subject of the research; and, (4) the presence of other indicators which show commercial potential for the idea. (P. L. 102-564) These additions tend to provide advantage to firms who undertake research with a more visible commercial application, in spite of the possibility that basic research, with an unknown potential of commercialization, may better serve the Government's purpose.

## **Problem Statement**

This new emphasis on commercialization generates concerns. The Act was established to provide a vehicle for small business to access Federal research and development funding through less cumbersome practices and procedures. In addition, the Act was established to generate innovative solutions to Federal Government problems. However, these revisions tend to steer research efforts toward the needs of the commercial marketplace rather than toward efforts which address Government concerns foremost. Further, the increased emphasis on commercialization has placed a new obstacle in the path of firms which have limited marketing skills.

My exploratory research focused on whether or not this new emphasis on commercialization is burdensome to the participating small business SBIR contractors. The spirit of the Act appears to suffer when commercialization becomes the major focus of research efforts and award evaluation. Among these potential difficulties are an increase in procedural complexity, pressure to pursue a specific type of research, and inequitable treatment.

First, small businesses will have to expend resources tracking down funding for potential innovations developed in the first phase of the SBIR contract. This requirement takes resources away from the basic research effort.



Second, the pressure to identify a commercial application from the onset of development forces the research to emphasize engineering rather than innovation. Last, large businesses, who receive a preponderance of research and development funding, are not required to submit information that delineates a potential commercial application or identifies potential non-DOD investors. Additionally, award criteria does not address the existence or merit of the evidence submitted. Consequently, small businesses who must subscribe to these evaluation criteria are required to expend extra time and resources just to be considered for awards.

### **Contribution of the Study**

This study examines the potential impacts of recent changes to the SBIR program. Although there are many studies of the SBIR program, these studies evaluated the general ability of the program to meet Federal acquisition goals. None of the studies considered the effort and perceptions of the small business participants. The SBIR Act mandates periodic review of the program; however, these reviews focus on issues from the government's perspective. Unfortunately they tell us little about the impact of the SBIR Act on small business. This study hopes to remedy this shortfall in the research.

This research was conducted using case-study methodology. According to Robert K. Yin, "case studies allow an investigation to retain the holistic and meaningful characteristics of real-life events" (Yin, 1989:14). In general, the case-study approach allows one to explore the research questions and still minimize researcher bias. More importantly, it allows the researcher to focus on contemporary phenomena within a "real-world context," increasing external validity and generalizability. A case study also allows analysis of the perceptions caused by the new emphasis in commercialization within the SBIR program, as it is understood by those most directly affected by it, namely small business contractors.

Results from this exploratory research will provide insight into what small business believes it is paying to participate in the program. More specific data can be collected once general issues are uncovered. Results of this study will support a recommendation to continue or modify the trend of emphasizing commercialization as an integral part of the SBIR program. This study's results will also form the foundation for further research into the overall effectiveness of such programs, particularly from the small business participant's perspective.

## Research Process

Based on the recommendations by Cooper and Emory, this study identifies the management question, research question, investigative questions, and measurement questions that guided the researcher. The management question "represents the problem confronting" administrators of the SBIR program (Cooper and Emory, 1995:56). This question is, "Is the emphasis on commercialization burdensome to the small business participants in the SBIR program?" The focus of this problem is on the broad and general level.

The research question provides a fact-based, information-gathering position. The research question "states the objective of the research study" (Cooper and Emory, 1995:58). These questions are, "What are the major factors that determine the extent to which small business participates in the SBIR program?" "To what degree is full participation by small business hampered by the requirement to seek commercial applications for their innovations?" This study will address these questions. Further, it will use the responses of the small businesses to find ways to make the SBIR program both attractive and responsive to the Act's goals.

The investigative questions which were the focus of the research are described below:

1. "Does the increased emphasis on commercialization limit the type of research activity that can be pursued through the SBIR program?" This question is designed to confirm whether the type of research undertaken by SBIR participants is focused more on the private or the public sector markets.

2. "Does the increased emphasis on commercialization favor those contractors who can readily locate and obtain outside funding for potential research?" This question seeks to determine whether the new emphasis abandons one of the original tenets of the Act which seeks to provide an opportunity to small businesses which is not otherwise readily available.

3. "Does the increased emphasis on commercialization and the requirement for a business plan penalize small business participants who have limited marketing capacity?" This question seeks to uncover any inequities in the requirements under which small business must perform.

4. "Is the increased emphasis on commercialization and the requirement to utilize resources to develop a business plan and locate alternative funding sources counterproductive?" This question seeks to find out whether Government involvement in a free market economy causes more harm than the good. Chapter two will discuss economic

theory and analysis that explains the nature of this phenomenon and its potential hazards.

### **Summary**

The primary purpose for the Government's involvement in the defense industrial base is that a strong defense industrial base means a more secure source for critical defense supplies and services and a healthier national economy. An analysis of the current environment suggests that some Government involvement may be beneficial while other involvement tends to produce harmful economic side effects. The existence of programs which give special consideration to certain industries is an example of beneficial involvement, while over-regulation of these programs is an example of less beneficial involvement.

The Small Business Innovation Research Program provides fertile ground for the exploration of both types of involvement. Over the life of the program, the Government has benefited by receiving innovative products and services. Additionally, the small business participants have received benefits by gaining access to the Federal marketplace and the funding available in the market. Often, these firms would not have been able to pursue or further their research efforts without the program. Recent legislative efforts threaten these benefits and may cause unnecessary barriers

to entry. This outcome could seriously reduce the size of the innovative idea pool.

The primary aim of this research is to address the question, on a preliminary basis, whether the recent legislative and policy emphasis on commercialization has significantly reduced or mitigated any benefits which might come from such a program. A study of cases which simulate the various characteristics of participating contractors is expected to facilitate the identification of any need for modifying the program.

## II. Literature Review

Strong technological innovation is essential to the economic future of the United States. According to the former Office of Technology Assessment (OTA), in a study entitled, "Innovation and Commercialization of Emerging Technologies," one of the most important characters in the drama of innovation is the Federal Government. The United States spends more on research and development, in absolute terms, than any other nation; however, other nations are challenging our long-standing technological dominance.

The former OTA believed that the United States is falling behind technologically. It argued, more than any other nation, the United States has been directing its research and development effort towards defense technologies. It suggested the technological growth realized through the promotion of defense technology has provided fewer benefits for today's technology base. The Government has historically played a strong research role but has left commercialization to private companies. The OTA study confirms that a shift in the Federal emphasis is necessary. The Government needs to establish programs that share with industry the cost of pre-competitive developmental research and establish help for small firms to access the most advanced technologies.

Some suggest that caution should be placed on the development of these programs to prevent excess dependencies on these potentially useful programs. According to an article by David Hanson and other proponents, programs like the Advanced Technology Program and the Manufacturing Technology Centers validate the success of Government assistance. However, opponents criticize the programs for being a case of Government interference which skews market forces and is simply "corporate welfare" (Hanson, 1995). In light of this issue, opponents argue that policy makers should focus their attention on the interaction of Government and market forces through programs like the Small Business Innovation Research (SBIR) program. Specifically, they believe policy makers should find the best way to structure such relationships and thereby provide the greatest benefit to the public and private sectors. This study examines which perspective is justified.

### **Organization of Chapter**

This literature review begins with a list of terms which are used throughout the document. Next, a theoretical foundation for the research is laid through discussion of technology as a competitive strategy, the use of small businesses to develop technology, and the regulation of competition in the defense industry. An analysis of the



applicability of these concepts is also provided. Additionally, a chronology of the studies and reports on the SBIR program detailing the evolution of its success is presented. Last, an explanation of the research design concludes the chapter.

### **Definition and Explanation of Terms**

The following terms are defined to provide understanding and guidance for their use throughout the research effort.

Small Business: Small businesses are "firms, including their affiliates, that are independently owned and operated, and are not dominant in the field of operation in which it is participating for Government contracts" (Arnavas and Ruberry, 1987:6-4).

Small-Disadvantaged Business: Small-disadvantaged businesses are "small businesses that is at least 51% owned by one or more individuals who are both socially and economically disadvantaged" (Keyes, 1985:150).

Socially Disadvantaged: Socially disadvantaged individuals are "people who have been subjected to racial or ethnic prejudice or cultural bias because of their identity as a member of a group without regard to their qualities as individuals" (Keyes, 1985:150).

Economically Disadvantaged: Economically disadvantaged individuals are "people whose ability to compete in the free enterprise system is impaired due to diminished opportunities to obtain capital and credit as compared to others in the same line of business who are not socially disadvantaged" (Keyes, 1985:150).

Defense Industrial Base: The defense industrial base is the number and variety of defense contractors available to satisfy the needs of the Government for supplies and services, including, but not limited to, needs for research and development efforts and engineering support.

Competition: The use of the term, competition, is limited to "the existence of other viable firms in any market which the Government has a supply or service need" (Soderquist, 1979:16). Competition is not used to refer to political, economic, or quality considerations.

Federal Agency: A Federal agency means "an executive agency as defined in section 105 of title 5, United States Code or a military department as defined in section 102 of such title. The primary Federal agency of interest in this study is the Department of the Air Force" (P. L. 97-219: Section 4).

Research or Research and Development: The term means "(1) any activity which is a systematic, intensive study directed toward greater knowledge or understanding of the

subject studied; (2) a systematic study directed specifically toward applying new knowledge to meet a recognized need; or (3) a systematic application of knowledge toward the production of useful material, devices, and systems or methods, including design, development, and improvement of prototypes and new processes to meet specific requirements" (P. L. 97-219: Section 4).

### **Conceptual Foundation**

Before discussing previous research conducted on the Small Business Innovation Research program and how the new emphasis on commercialization impacts its implementation, an explanation of two concepts provides a greater understanding of the relevance of this research. These two concepts are the use of Government regulation to affect competition and the use of technology development as a competitive strategy. Both concepts relate to how commercialization and Government involvement can promote or hinder the success of the SBIR program.

### **Regulation of Competition**

According to Papandreou and Wheeler,

it is customary to associate 'laissez faire' and private enterprise with the American economy ... yet the increasing participation of Government in the economic life of the country results from the pressing national needs. (Papandreou and Wheeler, 1954:3)

Some view these developments with concern while others have accepted them as indicators of a responsive democracy.

In Papandreou and Wheeler's simple model of a laissez-faire economy, the basic process centers on exchange and production. For exchange to take place, three conditions must be met. First, the parties must be in control of the commodity being exchanged. Next, the parties must be capable of transferring this control. Last, the parties must find some advantage in the exchange. The exchange itself is a social process, while the production is a technological process independent of the social context in which it takes place. This type of environment is considered to be a free economy whereby the conditions are considered to be the same for all participants (Papandreou and Wheeler, 1954).

In reality, conditions are not equal. This is the basis for most criticism of the "laissez faire" economy, especially as it relates to the Department of Defense and other technical marketplaces. Dr. Jacques S Gansler, former Deputy Assistant Secretary of Defense for Material Acquisition and former assistant director of Defense Research and Engineering, acknowledges that

in terms of the traditional economic criteria for industrial organizations, it is clear that business operations between the United States Government and the defense industry deviate widely from the conventional free market theory. (Gansler, 1980:1)

Peterson further states that

we sometimes forget that our economic system incorporates a full range of economic environments and draw incorrect conclusions concerning economic activities that operate outside the "normal" range of capitalistic functions. (Peterson, 1987:105)

A significant difference between the defense industry and free market is that instead of many buyers and sellers, the defense industry is a monopsony, having one buyer which is the Government. Further, it is an oligopoly, having a few suppliers to meet mission needs. As a result, laws and regulations are enacted to stimulate as competitive an environment as possible under these conditions. If this effort is not made, the Government is left with three choices when it needs to acquire products or services from a noncompetitive industry (Gansler, 1980). The first choice is to refuse to acquire the items until a competitive market develops. Depending on the priority, this may not be the most practical decision. Next, the Government can acknowledge the noncompetitive market and make the best of it, establishing effective and efficient policies that address specific needs based on the situation. This is the least powerful negotiation position for a buyer. Lastly, the Government can invest the time and resources necessary to encourage other sellers to enter the market. Although critics emphasize the potential for over-spending just to

create competition, in the long run, this option appears to be a more viable alternative for this environment. In fact, legislation has been established and an administrative framework put in place that recognizes this situation.

The research and development industry is an example of how laws address the potential lack of competition and the need for Government involvement. "Policy makers, otherwise devoted to the free market, are pursuing what is in effect a targeted industrial policy for high technologies" (Reich, 1989: 41). Still there are some who believe that despite Government involvement, the "invisible hand" of the market forces will prevail. Notwithstanding, the Government continues to exert its power for the benefit of the public and private industries.

### **Government Sponsorship**

Without the involvement of Government in some industries, small businesses would not have an adequate opportunity to compete. According to Flynn, this involvement is called sponsorship. "Sponsorship includes the intervention by Government agencies to create an environment conducive to the birth and survival of organizations" (Flynn, 1988:51). This activity increases the likelihood that a firm will be able to perform within a given market.

History has demonstrated that an organization's survival is contingent upon available resources (Lawrence and Lorsch, 1967). These resources, termed infrastructure, may exist in the local environment as a composite of land, labor, capital, and the existing organization. Also, resources may be provided by public and private organizations through the sponsorship process. These two primary sources of resources have been shown to be important contributors to the emergence and survival of new organizations (Flynn, 1990). Sponsorship increases the amount of resources available and provides an opportunity for organizational formation and sustainment.

In its earliest development, sponsorship protects the new organization from some of the environmental threats in the general and specific environment (Hall, 1982). This reduces the potential adverse effects that arise during the vulnerable early stage of the organization's development (Stinchcombe, 1965). And since no organization is self-sufficient, the sponsorship arrangement may create certain dependencies among organizations. The importance of the resources determines the extent of dependency (Pfeffer and Salancik, 1978).

The resource-dependence model highlights the importance of the strategies new organizations and their sponsors take to deliberately increase the level of resources available.

When sponsorship takes place, the provision of resources and the conditions accompanying this acceptance increase the dependence of the new organization on the environment. However, the dependence is benevolent since the sponsor provides support for survival in the short term. Sponsored organizations accept this dependence as a means of increasing the chances of future survival (Flynn, 1993).

Dependence makes it easier for the focus to be on the product or process development rather than on mapping competitive strategies for survival (Porter, 1980). The SBIR program is a special example of how this principle is manifested. By receiving funding from the Government, the small business can focus its attention on creating an innovation that meets mission needs. This directed effort produces more reliable and technologically superior output. With this superior product, firms can develop a reputation that encourages other organizations to invest in their ideas thus relieving the sponsor and the organization of some of the dependence.

It is important that sponsorship possess a complementary focus on helping to create self-organizing systems within the organization. Without it, the new organization may develop an over-dependence on sponsors and become vulnerable. Sponsorship is most effective when the existing and expected industry is considered in developing



the firm's goals. Consequently, within the SBIR process, the commercialization emphasis is beneficial when considered as part of the whole, especially in a technology-rich market environment.

### **Government Technology Innovation**

One area where Government involvement in creating competition has been increasing is in the technical innovation industry. Federally-funded research and development efforts have become a growing part of many agency budgets. Specifically, within the Department of Defense, laboratories and scientific contractors have become an integral part of the emerging defense industrial base. An understanding of how the Government exerts its influence in this area provides an understanding of how it can be tailored for maximum effectiveness.

One of the ways the Government regulates technological innovation is through the use of laboratories. Agencies commission laboratories to further research and development effort commensurate with the needs of the organization. This activity is commonly referred to as "vertical integration." By "bringing the additional stages of production within its control, the Government regulates the extent to which innovation is moved forward" (Papandreou and Wheeler, 1954). This activity is common among monopoly and

monopsony organizations. However, the major difference in the Government's actions and the private sector's actions is that the Government considers the benefit to society in executing this process. In creating an internal structure to provide its needs, the Government creates employment and business opportunities through the development of innovation and the potential sharing and transferring of innovation to the private sector.

### **Government Technology Commercialization**

The use of laboratories and other programs furthers the Government's goals of transferring innovations to the private sector for the benefit of the public. Winebrake studied the process extensively and revealed that "the private sector under-invests in basic technical research and development" (Winebrake, 1992: 54). According to Winebrake, there are two reasons for this lack of support. First, the fact that not all investments are recouped by the investing firm causes companies to steer away from innovations that do not have a visible commercial and profitable application. Second, the perceived high risk of research and development is insufficient motivation for private involvement, especially as it relates to the defense industrial base (Winebrake, 1992).

An extensive study by the MIT Commission on Productivity acknowledges that the US government's involvement is needed to sustain the economy through commercialization (MIT, 1989). Another study, conducted by Washington's Council on Competitiveness, suggested that the movement of ideas from Federal laboratories to private industry and the commercialization of these ideas be a top national priority. It emphasized the need for the Government to widen its focus and broaden cooperative relationships with private industry (Washington Council, 1988).

In response to this study, the Department of Defense and other agencies have increased emphasis on employing scientists and engineers, requiring agencies to expend a percentage of their budgets specifically for research efforts. This increase in scientific resources is expected to enhance US competitiveness by increasing technology transfer and commercialization of federally-funded technologies. These technologies range from product technology to complex technology. They also range from standards and practices to simple information transfer.

The use of small business to accomplish this task has been deemed most effective. Accordingly, small business has been provided special consideration, through legislation, that promotes its use in commercialization efforts

(Radosevich and Lombana, 1993). Although there are some concerns about the problems associated with working with small businesses, the Government continues to increase the use of small businesses. The major concern, information access, is being addressed through outreach programs like the program established as part of the SBIR program. This program actively targets disadvantaged businesses in an attempt to encourage them to participate in the program. A more detailed discussion the SBIR program will be presented later in the chapter.

However, before discussing a particular way in which commercialization is done, a review of the possible relationships should be conducted. This review may provide alternatives which may allow commercialization to be accomplished more effectively. Dudley and Rood identify three types of relationships in which commercialization could exist. First, the Government could contract out some of the roles of research and technology commercialization to pre-existing companies. These brokers would serve the role of a "dating service" where they match technology innovation with interested users. Second, using a indirect third-party intermediary, the Government can use outside contacts to locate interested parties for available research. In this case, the Government uses an organization, who is within the Government, but not the laboratory, actually doing the

research. Last, the Government can use direct multi-organizational partnerships. The Government establishes agreements with other organizations to promote technology transfer and commercialization after performing joint research and development. These agreements offer the opportunity to combine different viewpoints, conditions thought to favor innovation (Dudley and Rood, 1989).

The Government's involvement in this effort suggests that it is aware of the lack of invested interest in this area. Consequently, it is willing to regulate innovation for the good of the public. The establishment of legislation and programs to execute innovation and commercialization is evidence of the Government's willingness to accept the challenge.

### **Technology Strategy**

The use of technology as a strategy is not a new concept. However, the method in which this strategy is being implemented requires an understanding of the basic concept of technology strategy. By definition, technology strategy is a firm's approach to the development and use of technology (Porter, 1985). In this study, the subject firm is the Government and the approach focuses on how the Government plans to direct research efforts, conduct

research and development, and use the innovation which results.

In the traditional sense, technology strategy is used to gain a competitive advantage over other participants in the industry. For the Government, this strategy is used to gain the most from the innovation effort of small businesses. The more users that can be located for the resulting technology, the more successful the effort. One of the ways Porter suggests maximizing this benefit is by "finding, exploiting, and creating technological interrelationships" among other organizations (Porter, 1985:200). In this way, the Government gains the benefit of a solution to key research questions while opening up the opportunity to share some of the costs associated with developing the idea.

Pursuing this strategy in our dynamic economy is a basic goal of the program. Clark confirms technology innovation as a way of providing an opportunity for small businesses to gain entry into a market which also supplies Government needs. The initial monopoly that it creates provides a greater chance for businesses to succeed. The further commercialization of the innovation provides the large scale penetration and exposure necessary to become and remain viable (Clark, 1961).

## **Small Businesses for Technological Innovation**

Researchers have concluded that small businesses are the most effective institutional mechanism for the execution of technological innovation in the United States. Not only does the Government provide special considerations to be rendered to small businesses, but there are several advantages to doing business with a small business structure. First, small businesses do not have the bureaucracy that hinders their seeking innovative solutions. Large firms are often preoccupied with profit maximization and therefore forego high-risk technological advancement to pursue increased sales. Second, small firms can operate at a smaller scale. This operational mode allows more attention to be placed on the innovative solutions. Third, small businesses are often seeking ways to enter the market with distinctive products rather than trying to compete in an existing market. They realize it is difficult to compete with large businesses who have loyal consumers and economies of scale. The small businesses seek "niche markets with high margins" (Radosevich and Lombana, 1993:27). Last, geographic market fragmentation demands that local needs be filled through customized applications. Small businesses can provide this responsiveness. With sufficient technical expertise they can take advantage of this opportunity and create competitive advantage.

There are, however, some barriers to overcome to ensure small businesses remain the most efficient means of innovating technology. First, bureaucracy must be minimized to allow small businesses to exercise their maneuverability through the decision-making process. Second, small businesses may not have the facilities to accommodate the technological advancement. Assistance may be necessary in the areas of marketing, sales, and other avenues for reaching commercial markets. Last, small businesses may not have the ability to recover all costs associated with the innovation. Although they accomplish the research and development at a lower cost than large business, financial considerations are still necessary.

With these advantages and disadvantages in mind, it is important to develop and tailor a program that addresses each concern. The Federal Government must use a mechanism that accomplishes the technological advancements, using small businesses, in a less cumbersome way. These factors should be considered throughout the life of the program and monitored to ensure the goals of the program continue to be met. Last, the program should consider both the needs of the Federal Government and the small business contractor it serves.



## **Small Business Innovative Research Program (SBIR)**

The SBIR program illustrates the Government's attempt to provide small businesses a competitive advantage through technological innovation. Small business are thought to have little or no chance of formation or expansion without this sponsorship. A chronology of the program's evolution provides insight into the impacts of Government involvement and the resulting effects.

The 1982 Small Business Innovation Development Act established the SBIR program to stimulate technological innovations among small businesses while providing the Government new, cost effective techniques and scientific solutions to challenging problems. At the same time, the SBIR program encouraged small businesses to market the SBIR technology in the private sector, further stimulating the United States economy.

SBIR provides a competitive opportunity to propose innovative concepts for meeting the research and development needs of the Federal Government. The results have been important to national defense and to the work of other Federal agencies. The expense carried by the research and development industry is usually beyond the means of small businesses and places them at an immediate disadvantage. The SBIR program helps to "level the playing field" at the front-end of the process by funding high-risk research and

allowing the best ideas to surface. At the tail-end of the process the SBIR program also provides the opportunity for and encourages commercializing the results of the SBIR project while lowering the investment risks for private investors (USAF, undated).

The initial objectives of the program were to stimulate innovation, use small businesses to meet research and development needs, encourage participation by minority and disadvantaged firms, and increase private sector commercialization. The SBIR program uses a three-phased, competitive process to meet these objectives. Phase I determines the feasibility of the new technology. Phase II is awarded to a successful Phase I contractor to

accomplish the research a development necessary to produce a well-defined, deliverable product or process. Phase III supports two important goals. The first is to apply the technology to solve the defense-related problem and second to convert the research into a commercial product. (USAF, undated(b):3)

Based on benefits realized, the original Act (Public Law 97-219) has been extended several times. Public Law 99-443 extended it until 1993 and Public Law 102-564 extended it until 2000. These benefits include, the Government receiving its innovative scientific/technical solutions, businesses establishing highly productive partnerships, and the Government transferring technology into the private sector stimulate the United States economy. The small

businesses receive solid funding for high-risk research and development, entry into Government contracting markets, credibility in seeking future capital investment, and an avenue to commercialization.

As part of the Act, reports on the effectiveness of the program were mandatory. The early reports focused on evaluation and selection procedures that reduce the cumbersome nature of Federal Government procurement. With respect to commercialization, reports suggest "research needs and priorities were usually given emphasis over innovation and commercialization" (GAO, 1987:18). Further, the reports indicate commercialization was considered when granting funds or when specifying the research topic; however, most times, it was considered a "tie-breaking" factor; rather than a selection criteria.

When reporting on the benefits of the program, firms generally limited their discussion to funding issues. Commercialization benefits were not specified. Additionally, the businesses and agencies commented on their opportunity to do basic, high-risk research. Other comments centered on improvements in the administrative processes. Solicitation clarity and deadlines were the usual focus. Overall, these surveys showed that the participants were "generally satisfied" (GAO, 1987b).

One issue raised in a report to the Chairman, Subcommittee of Innovation, Technology, and Productivity was one of large research and development efforts. The issue was whether it was required that SBIR participants be involved in large efforts. The findings of the report indicated that no SBIR contractors were participating in large efforts and that outreach programs may encourage small business participation (GAO, 1988).

Later reports acknowledged the requirements expressed in the 1986 Act to conduct a study on commercialization; however, data and information were not available to provide any conclusive results. Reports suggested that all other goals were being considered and monitored and no recommendations were proposed. The reports did acknowledge that the research being undertaken would not likely have been funded without SBIR (GAO, 1989).

Once recommendations began to surface, they tended to focus on making the program more accessible to small firms. Lowering of thresholds and set-asides were among the issues raised. These recommendations were hindered only by the need to review commercialization data before implementing any changes. Policy makers thought the recommendation that sought to increase funding would benefit from this additional information (GAO, 1989b).

It was not until 1992, with the enactment of Public Law 102-564, that significant changes in the program began to occur. In addition to increasing the emphasis in commercialization, the program establish a pilot program specifically targeted toward research institutions. The Small Business Technology Transfer Pilot Program (STTR) reserved awards for research and development through a uniform process similar to the SBIR program. The difference in that program was that the STTR program joined highly technical small businesses with research universities and institutes. The separately-funded program shared the goals of economic growth and strengthened the defense technological industrial base. Secondary to the notion of innovation was commercialization. The program was designed for small businesses to tap into the wealth of information at research institutions (USAF, undated).

One report submitted after this change in the Act emphasized the need to increase the commercialization aspect of program. Berger, Little, and Saavedra outlined the present commercialization activities and concluded there was considerable commercialization being executed without increased emphasis. This report contributed to the first GAO study on commercialization and the SBIR program (Berger and others et al., 1992). GAO identified the various categories of activity. It also highlighted the additional

actions agencies were taking to increase commercialization. One such activity was to require Phase I contractors to provide a business plan on potential commercialization efforts with their proposal. This trend of reporting commercialization information continued, and other reports highlighted efforts to further commercialization. Agencies were encouraged to take some action (GAO, 1995); however, they were not required to perform any specific actions.

This increased focus on commercialization prompted the Department of Defense to convene a Process Action Team (PAT) to make recommendations on the program. Among these recommendations was a specific plan to require business plans that outline future commercialization activities. In its final report, the PAT recommended that Phase I proposal include a one- to two-page commercialization plan to be used in evaluation for award. This plan required small businesses to identify third-party, non-SBIR funding sources. Critics believed that this action undermined one basic intention of the program: to provide small businesses with an opportunity to do research. Contractors who could supply this information were not likely to need the SBIR funding; especially if they can locate potential funding sources on their own.

## Summary

Throughout the history of the American economy, some form of Government regulation has been necessary to protect the collective interests of the public. This literature review illustrated the need for regulation involving technology innovation and the small business community. The manifestation of this involvement is evident through the SBIR Program and the evolution of its policies and processes.

The theoretical foundation is laid through the discussion of the regulation of competition and the use of a technology strategy. Regulation of competition is demonstrated through Government sponsorship due to a need to inject the industry with more competition in the technological industry. The Government covers a shortfall by making special considerations for the formation and sustainment of firms who develop advanced technology. The use of a technology strategy contributes to the differentiation of business based on their motivation to innovate. The culmination of these two concepts are in the existence and continued evolution of the SBIR Program.

GAO reports describe the nature of the SBIR Program and the many changes which have taken place in the program to perfect its outcomes. The goals of the program remain the same, yet the emphasis on specific goals tends to fluctuate.

The most recent reports show that the latest trend is emphasis on commercialization.

### **Propositions**

Based on the findings of the GAO reports discussed above, the following propositions are specified:

**Investigative Question 1.** "Does the increased emphasis on commercialization limit the type of research activity that can be pursued through the SBIR program?"

Proposition 1A. Increased emphasis on commercialization stifles the freedom to innovate.

Proposition 1B. Preoccupation with commercialization hurts the Government's goals of developing innovative solutions to Government problems.

**Investigative Question 2.** "Does the increased emphasis on commercialization favor those contractors who can readily locate and obtain outside funding for potential research?"

Proposition 2A. Contractors who have already developed a technological idea which demonstrates commercial potential are more likely to win SBIR contracts.

Proposition 2B. Evaluation criteria place excess emphasis on commercial potential.

Proposition 2C. The emphasis on secondary funding sources biases the evaluation process in favor of firms with research ideas that cater to the private markets.



Proposition 2D. Contractors who can readily locate alternative funding sources do not need the SBIR program to enter commercial markets.

**Investigative Question 3.** "Does the increased emphasis on commercialization and the requirement for a business plan penalize small business participants who have limited marketing capacity?"

Proposition 3A. The requirement to submit a commercialization business plan is cumbersome to small firms with limited marketing capacity.

Proposition 3B. The requirement to submit a business plan is an unfair practice considering large business do not have a similar requirement.

Proposition 3C. Preparation of a business plan drains scarce resources which could be used to conduct scientific research.

Proposition 3D. Other methods can be used to stimulate small businesses to seek alternative funding sources.

**Investigative Question 4.** "Is the increased emphasis on commercialization and the requirement to utilize resources to develop a business plan and locate alternative funding sources counterproductive?"

Proposition 4A. Focusing on commercialization takes the focus from innovation.

Proposition 4B. Policy makers do not investigate the impacts to small business before instituting policy changes.

Proposition 4C. Emphasis on commercialization and emphasis on innovation are divergent viewpoints.

These propositions will be used in this exploratory study to fill the research gap that exists as a result of other studies. The information generated from the interviews will identify issues that are affected by the recent commercialization emphasis. The study will provide preliminary information that can be used in future studies to gain a greater understanding of how the SBIR program can be executed more efficiently and effectively.

### III. Methodology

#### **Organization of the Chapter**

This chapter discusses the research design. First, it outlines the reasons for selecting a case study methodology. Then, it explains why this design is the most appropriate methodology. A discussion of the components of the case study design is continued from Chapter II. Next, the chapter describes the unit of analysis, the logic linking the data to the propositions, and the criteria for interpreting the findings. Last, the chapter concludes with an explanation of the case study protocols.

#### **Case Study Design**

This research attempted to learn how the recent changes in the SBIR Act have affected the perceptions of small businesses. The research attempted to determine the benefits and shortcomings of the program. Conclusions support recommendations to alter the program's procedures and processes in order to be more responsive to the original intent of the Act. Yin suggests that case study methodology "has a distinct advantage when a "how" or "why" question is being asked about a contemporary set of events over which the investigator has little or no control" (Yin, 1994:5).

Case studies secure data from multiple sources and allow the researcher to verify among sources, increasing the likelihood of observing all significant data. Cooper and Emory add that case studies "place emphasis on a full contextual analysis of fewer events and their interrelations. An emphasis on details provides insights for problem solving and evaluation" (Cooper and Emory, 1995:116-117). The perceptions of small businesses can best be analyzed within the context of a discussion about their participation in the SBIR program.

The research approach used was open-ended interviews. There were no empirical studies available and direct observation was inappropriate. Exploratory study was necessary for the immediate purpose of the research which was to develop hypothesis for future research. The approach attempted to reveal perspectives of SBIR participants. Discovery of such information through a survey is premature. Further, surveys are expensive and with such a small population, telephone interviews were found to be more economical given the limited nature of this initial study.

### **Research Design**

Yin outlines the five components of a research design as including "(1) the research's investigative questions, (2) its propositions, (3) its units of analysis, (4) the

logic linking the data to the proposition, and (5) the criteria for interpreting the findings" (Yin, 1989: 29). Each investigative question, outlined at the end of Chapter II, clarifies the nature of the study questions. Each proposition, also outlined at the end of Chapter II, directs attention to something that should be examined within the scope of study. The unit of analysis relates to defining what a "case" is to represent. For this research, a "case" is a small business who is participating in or has participated in the SBIR program and the unit of analysis is the firm. The logic linking the data to the proposition is evidence validating the proposition. The linking data uses "pattern matching." According to Yin, pieces of information from the cases are related to one or more of the propositions. Last, the criteria for interpreting the findings will relate to generalizations made in Chapter II.

### **Unit of Analysis**

Data related to this research was collected from five past and present participants in the SBIR program. The participant pool was limited to contractors who provide innovative technology to the Air Force. Each case represents a contractor who submitted at least one proposal against a SBIR solicitation. Included in the population were cases in which a Phase I contract was awarded. The

time-frame considered in the study focused on the subjects perceptions from the time the subjects considered submitting a proposal through the present. All perceptions of the program were considered valid for this research. The number of proposals submitted through the SBIR program was not considered significant.

The population of cases was limited to the Air Force SBIR program for several reasons. First, it was convenient to select Air Force cases as the target population. The Air Force SBIR Program Executive Office maintains an active database of all present and past participants. Seven cases were identified through a search of the records in the SBIR Program Executive Office. Five of these participants were willing to address issues pertaining to the program without fear of releasing proprietary data. Finally, no travel funds were available to support the research.

#### **Logic Linking Data to Propositions**

The pattern matching technique was used to link the data to the proposition and facilitate the subsequent analysis. Yin contends that pattern-matching is one of the most desirable strategies for case study analysis. This strategy "compares an empirically-based pattern with a predicted pattern or several alternative predictions" (Yin,

1994:106). Variables of interest, derived from the concepts outlined in Chapter II, are included in Table 2.

TABLE 2  
RESEARCH VARIABLES

VARIABLES	PROPOSITION	DEFINITION
Business Size	1A, 1B, 2A	Number of employees
Primary Products	1A, 1B, 2A, 2D, 3A, 3C, 4A	Focus of company's business
Participation in the SBIR Program	1B, 2A, 2B, 2C, 2D, 3A, 3B, 3C, 4A, 4B, 4C	Historical activities with SBIR Program
Research and Development Activities	1A, 1B, 2A, 2B, 2C, 2D, 3A, 3B, 3C, 3D, 4A, 4B, 4C	Extent and focus of research and development efforts
Seeking Commercial Application	2A, 2C, 2D, 3A, 3B, 3C, 3D, 4A, 4C	Extent of marketing activities for innovations
Ability to Innovate	1A, 1B	Extent to which participation influences ability to innovate
Assistance	2A, 2D, 3D, 4C	Degree of assistance provided to innovation
Hindrance	1A, 1B, 2A, 2B, 2C, 3A, 3B, 3C, 4A, 4B	Degree of hindrance provided to innovation
Usefulness	1A, 1B, 2A, 2C, 2D, 3A, 3B, 3C, 3D, 4A, 4B	The extent to which the program is perceived as being useful
Reliance	2A, 2C, 2D, 3D, 4A, 4B, 4C	Extent to which innovation depended upon SBIR funds

TABLE 2 (con't)

VARIABLES	PROPOSITION	DEFINITION
Realism	1A, 1B, 2A, 2C, 2D, 3A, 3B, 3C, 3D, 4A, 4B, 4C	Extent to business plans are realistic requirements
Fairness	2A, 2C, 2D, 3A, 3B, 3C, 4A	Degree to which submitting a business plan is fair
Commercialization Plan (Participate)	3A, 3B, 3C, 3D, 4A, 4B, 4C	Impact of submitting business plan on participation
Commercialization Plan (Innovate)	3A, 3B, 3C, 3D, 4A, 4B, 4C	Impact of submitting business plan on innovation

Miles and Huberman suggest that pattern coding be used throughout data collection and analysis as means of efficiently labeling and retrieving data (Miles and Huberman). The codes were based on the entire research design. Preliminary codes were assigned prior to interviewing. Final pattern codes were revised according to emerging themes from the interview process. These patterns were identified by "isolating something that happens a number of times and consistently happens in a specific way" (Miles and Huberman, 1984:215). This technique is descriptive in nature and appropriate for the use in exploratory studies. The pattern codes are listed in Appendix A, along with the corresponding operational definition and the investigative questions to which they are linked.



## Criteria for Interpreting Findings

The researcher attempted to generalize the findings collected from the interviews with SBIR participants. Using the theories outlined in Chapter II, the findings were interpreted.

First, the need for Government to influence market forces is based on the negligence of the market leaders to be responsive to all market needs. "Laissez-faire" economics alone is not sufficient to encourage innovation. The return on investment is too small to induce an interest by the private sector. Therefore, Government sponsorship is necessary to support small businesses in filling this gap.

The second concept is that of technology as a competitive strategy. The SBIR program considers technology a way for small businesses to gain entry into the marketplace. Support for this theory would be found if the SBIR participants reported that once an innovation was developed, commercial players expressed interest in their efforts. Additionally, support would be found if the emphasis of commercialization caused innovation to be focused on that particular technology.

A final concept investigated in the research is the notion of small businesses being used to promote technological development. Small businesses provide advantages when used for innovation. Support for this

theory will be found if the business reported minimal bureaucracy as a benefit to participating in the program.

### **Case Study Protocol**

Protocol contains the instrument, procedures, and general rules associated with the study. The elements of protocol include the overview of the research, the sources of information, the case study questions, and the database of collected information (Yin, 1995).

### **Overview of the Study**

Participants were contacted and asked to participate in the study. They were informed about the purpose of the study and guaranteed confidentiality in order to encourage open dialogue. Data were shared freely with the members of the research committee and were summarized to protect participant confidentiality.

### **Sources of Data**

The research addressed the perceptions of the participants in the Air Force SBIR program. Participants were defined as small businesses who have submitted at least one proposal against a SBIR solicitation. The perceptions of these participants were essential to the research.

Recommendations for improvements to the program will be the basis for further studies.

### **Case Study Questions**

A list of the basic questions asked during the interview is provided at Appendix B. The questions were tailored from the investigative questions. The questions facilitated the acquisition of data necessary for the researcher to draw conclusions. The questions were open-ended to allow frank discussion and a flow of ideas and recommendations. Follow-up questions were asked to clarify responses during the actual interview.

### **Database**

Notes were taken during each interview and refer directly to a specific interviewee. Codes were used to identify each participant to protect the identity. Pattern coding was used to identify which response relates to a particular research factor. Direct relationships were drawn where possible.

### **Summary**

The goal of the research was to explore the impact of recent changes in the SBIR program on the perspectives of the participants. The research also investigated the extent

to which the Act's original goals are being met. The recent changes suggest a shift in the primary focus of the Act. This research is designed to validate this notion.

Several steps were taken to ensure the validity and reliability of the research. The multiple case-study design and the use of broad investigative questions facilitated discovery of findings that may lead to improvements in the program. Multiple sources and pattern-matching improved validity. Case study protocols ensured reliability.

The results of this exploratory research will assist decision makers in tailoring the program to achieve its goals more effectively. Additional research can be accomplished once specific areas of improvement are identified. This input is reported and analyzed in Chapter IV.

#### **IV. Results and Analysis**

Detailed analysis was performed on information retrieved from five small businesses who have participated in the Small Business Innovation Research (SBIR) Program. This exploratory research focused on perceptions held by SBIR participants. A summary and analysis of the data is provided in this chapter. Additionally, the chapter discusses analysis of the findings as they relate to each investigative question and related proposition identified in Chapter III. The analysis is done across cases to ensure anonymity and confidentiality.

##### **Overview of Cases**

The Air Force SBIR Program Executive maintains an active database of all present and past participants. Seven cases were identified through a review of the records in the SBIR Program Office. The five participants used in this study were willing to address issues pertaining to the program without fear of releasing proprietary data. These were the only parameters used to select the case study subjects. Their input provides valuable insight into how the program is meeting its goals from the small business firm's perspective. Further selection criteria would insert

researcher bias and reduce the randomness of the opinions gathered.

Discussion of the data is organized around the questions used during the telephone interviews. Selected statements are used to highlight the perceptual climate of the respondents. Additionally, Table 3 provides a summary of the data collected. The study's pattern codes, which were defined in Appendix A, were used to group the data. Finally, general conclusions are drawn from the analysis of the data.

Table 3  
SUMMARY OF DATA

PATTERN CODES	CASE A	CASE B	CASE C	CASE D	CASE E
SIZE-Less 10	Yes	Yes	No	Yes	No
SIZE-10 to 20	No	No	No	No	No
SIZE-20 plus	No	No	Yes	No	Yes
PRIM-Def	No	No	No	No	No
PRIM-Nondef	Yes	Yes	Yes	Yes	Yes
PASTPART-None	No	No	No	No	No
PASTPART-P1	Yes	Yes	Yes	Yes	Yes
PASTPART-P2	No	Yes	Yes	Yes	No
PASTPART-P3	No	No	No	No	No
PASTPART-Prop	Yes	Yes	Yes	Yes	Yes
CURRPART-None	Yes	Yes	No	No	No
CURRPART-P1	No	No	No	No	No
CURRPART-P2	No	No	No	No	Yes
CURRPART-P3	No	No	No	No	No
CURRPART-Prop	No	No	Yes	Yes	No

Table 3 (con't)

PATTERN CODES	CASE A	CASE B	CASE C	CASE D	CASE E
NONSBIR-Yes	Yes	Yes	Yes	Yes	Yes
NONSBIR-No	No	No	No	No	No
CURRCOMM-Yes	Yes	Yes	Yes	Yes	Yes
CURRCOMM-No	No	No	No	No	No
FUTRCOMM-Yes	Yes	Yes	Yes	Yes	Yes
FUTRCOMM-No	No	No	No	No	NO
INNOVATE-Aids	Yes	Yes	Yes	Yes	Yes
INNOVATE-Hind	No	No	No	No	No
AINFAC-Fund	No	Yes	Yes	Yes	Yes
AINFAC-Info	No	No	No	Yes	No
AINFAC-People	No	Yes	No	Yes	No
AINFAC-Credit	No	Yes	No	Yes	No
AINFAC-Other	Yes	Yes	No	Yes	No
HINFAC-Fund	No	Yes	Yes	Yes	Yes
HINFAC-Info	No	Yes	No	Yes	No
HINFAC-People	No	No	No	Yes	No
HINFAC-Credit	No	Yes	No	Yes	No
HINFAC-Other	Yes	Yes	No	Yes	No
USEFUL-Yes	Yes	Yes	Yes	Yes	Yes
USEFUL-No	No	No	No	No	No
GOVACTHIN-Yes	Yes	Yes	Yes	Yes	Yes
GOVACTHIN-No	No	No	No	No	No
DEFIN-Helps	Yes	Yes	Yes	Yes	Yes
DEFIN-Hurts	No	No	No	No	No
PLANS-Help	Yes	Yes	Yes	Yes	Yes
PLANS-Hurt	No	No	No	No	No
PLANSTOPS-Yes	No	No	No	No	No
PLANSTOPS-No	Yes	Yes	Yes	Yes	Yes
COMMBARR-Yes	No	No	No	No	No
COMMBARR-No	Yes	Yes	Yes	Yes	Yes

Table 3 (con't)

PATTERN CODES	CASE A	CASE B	CASE C	CASE D	CASE E
CHANGES-Yes	Yes	Yes	Yes	Yes	Yes
CHANGES-No	No	No	No	No	No
RELIANCE-Yes	No	No	No	No	No
RELIANCE-No	Yes	Yes	Yes	Yes	Yes
DEPEND-Yes	No	No	No	No	No
DEPEND-No	Yes	Yes	Yes	Yes	Yes
STRAT-Yes	Yes	Yes	Yes	Yes	Yes
STRAT-No	No	No	No	No	No
FAIR-Yes	No	Yes	Yes	Yes	No
FAIR-No	Yes	No	No	No	Yes
REALISTIC-Yes	No	Yes	Yes	Yes	No
REALISTIC-No	Yes	No	No	No	Yes

### Demographic Information

Each case business employed less than 50 people. Three of the businesses employed less than ten people on a regular basis. The other two businesses employed between 20 and 40 people. Each business also consisted of employees who maintained several roles and functions. It was not uncommon for one person to hold more than one position within the business.

The primary products of each of the subject cases varied. Products included specialized sensor test equipment, thermo-mechanical actuators, backup power supplies for large equipment, electronic x-ray imaging systems, and



electromagnetic component motors for spacecraft. None of the businesses depend solely on the defense industry for their revenues. Although two of the businesses indicate that their the SBIR program was responsible for their primary start-up, each business maintains a defense and non-defense market. Many of the products produced have dual-use potential. One company primarily focuses on the non-defense market and used the SBIR program to further research and development areas which have a definite dual use application.

Past and current participation varied across the subjects. Each of the businesses has participated in at least one Phase I contract under the SBIR program. Three of the businesses have completed Phase II efforts. The only business that has participated beyond Phase II provided prototypes to the Air Force under the SBIR program. Additionally, two of the businesses are no longer actively involved in the SBIR program, while two other businesses are preparing Phase II proposals. Last, one business is operating as a subcontractor for another business who is pursuing a SBIR contract.

Research was being undertaken involving non-SBIR technological development. Activities range from independent advancements to SBIR-generated technology to operating under other grants to further SBIR-generated

research. Each business has been able to apply the technology explored through the SBIR program to some commercial application.

Each business has been pursuing non-defense applications. One business utilizes a marketing group and manufacturing representatives to seek commercial applications and opportunities. Another business is specifically seeking funding to continue to refine the SBIR-developed technology. The use of trade shows and field representatives is being considered for further commercializing business products. Teaming arrangements with original equipment manufacturing companies are also being used to further innovation. The dual use philosophy permeates each business.

The demographic information collected served as a framework for making inferences and drawing conclusions. The similarities among the subjects allow the researcher to make recommendations about the SBIR program that will benefit a specific segment of its participants. Other recommendations can be made based on the diversity of the subjects. The differences among the subjects indicate the wide variety of businesses who have access to and take advantage of the opportunities made available through the SBIR program. Their perceptions about the effectiveness of the program are the primary data sought through this study.

## **Perceptual Feedback**

The perceptual questions focused on several aspects of the program. These areas were centered on the goals of the SBIR program and the study. Subjects were queried about how the program influenced their ability to innovate, what impact commercialization had on their participation in the program, their reliance on the program as their primary means of supporting their business, and any recommendations that would improve the program.

All participants believed the program aided their effort to innovate. One business indicated that the SBIR program provided the resources to start the business. Each business stated that SBIR funding represented a major source of revenue. Another contribution made by SBIR was the expertise of the personnel who worked with the SBIR contractor to fulfill Government requirements. Support people identified problem areas in the technology and directed the research towards productive ends. Facilities and equipment were also cited as a benefit. A third benefit was the ability to establish credibility with industrial sources. Once the Government approves the technological idea, investors believe the risk is lowered and are more likely to contribute funding resources. Last, the SBIR program provides a bridge between concept and prototype. Providing seed money to develop an idea into a tangible

product is a major benefit gained when participating in the SBIR program.

Conversely, several factors were cited that hindered the business's ability to innovate. One business cited the requirement to provide proof of future investment early in the program as stifling to its creative activities. Another indicated that administrative demands, along with the time required to prepare and submit a proposal, limited the direction of its innovation. The subject indicated that as more effort was being placed on administrative activities, leaving less effort available for innovation. Skeptical perceptions about new, unproved technology tended to limit the creativity of scientists. Reworked engineering solutions are more likely to receive a favorable evaluation and the respective funding. The SBIR program proports to encourage innovative research. However, less innovative proposals tend to receive more awards, which send the message that less innovative solutions are preferred.

The subjects confirmed the usefulness of the SBIR program in many ways. In addition to the previously mentioned benefits, the partnership established between Government and business was credited for its utility. This relationship seeds the growth of innovative businesses. This activity is good for businesses, the Government, and the economy. Businesses praised the SBIR program because it

provided resources which were previously reserved for only educational organizations. Grants and funding are now offered to businesses dedicated to developing technology which will be marketed to the country and beyond. The SBIR program was seen as useful because it provided an opportunity for businesses to demonstrate the value of their innovations. Information from these demonstrations reached other businesses who potentially will invest in the advancement of the technology.

The subjects suggested there were some Government activities which hindered their efforts to fully participate in the SBIR program to be hindered. These are actions, taken on the part of the Government, at large and are not specific to any agency. Among these actions include tax legislation, employment rules, and procedural bureaucracy. With the specialized nature of the research and development industry, specialized employees are essential. Once an employee is identified as not contributing to the technical goals of the business, he or she is released. Unfortunately, as reported by one subject, the tax laws levy a sizable penalty once termination takes place. Additionally, the former employee capitalized on these laws by taking legal action. Some businesses felt the effort to hire consumed the energy of the business. This energy could be spent innovating. Capital gains tax policy also hinders

the innovators. Unless businesses make sufficiently large profits and secure investors early in the innovation cycle, the modest profits earned are quickly drained and there is little left to reinvest in further development. Several subjects considered the slow approval and contractual process cumbersome and inhibiting to innovation. The complicated nature of the evaluation process requires businesses to have resident experts to decipher the language and considerable resources to maintain operations while waiting for notification of award. Last, the businesses cited contradictory goals as another hindrance in innovation. The double message of "innovate" and "commercialize" leaves some businesses in confusion about which goal is the more important factor for determining who will receive the contract. The fact that not all innovation can be commercialized forces businesses to decide which one to abandon to gain access to the SBIR program.

A major focus of the SBIR program is the requirement to commercialize defense-related innovation. This dual-use emphasis had been adopted by two of the subject businesses. As a result, these businesses utilized the SBIR program to make inroads into other commercial markets. One subject considers this view of technology as "intrinsic to business." The other businesses recognize the benefits of the SBIR program encouraging dual-use technology innovation

as a means of expanding their business base, yet fear this benefit is realized to the detriment of their ability to conduct more "ground-breaking" research. While in agreement that this emphasis adds value to the product and multiplies investment potential, they feel that scientists are creatively stifled and forced to re-work old technology into new applications.

Involved in this requirement to commercialize is the requirement to submit a commercialization plan that outlines funding sources. This plan is required prior to the end of the Phase I contract. Four of the subjects consider the plans to be a valuable document that identifies weaknesses in the innovation and commercialization processes. However, one subject considers the document a bureaucratic exercise that provides marginal benefit. Further, the information provided in the plans could be potentially detrimental to the business because it outlines too much of the business's operations, such as its strategy for soliciting investors. The internal value of the plans centers on the requirement to think ahead and plan for future business outside the Government sector. Fortunately, the emphasis on commercialization and the requirement for the commercialization plan have not limit the participation of any of the subject businesses.

Another issue associated with the SBIR program is one of reliance and dependence. Critics of most Government-sponsored program fear small business will become too reliant on the Government and create situations, similar to "corporate welfare." None of the subjects considers businesses to be vulnerable to this situation. The consensus across subjects was that companies which make a practice of developing ideas contribute to this concern. These businesses, labeled "SBIR mills," seek only to win Phase I contracts and have no intention to produce a product. As the Government places more emphasis on commercialization, these businesses are less likely to win SBIR awards. Additionally, one subject suggested that the funding provided by SBIR was not adequate to produce dependence beyond the level of providing paper studies. As a result, all subjects report that their strategy to counter the potential for reliance and dependence was the pursuit of non-SBIR investments and grants.

Another issue associated with recent trends within the SBIR program is the uniqueness of the commercialization plan requirement. Other research and development acquisition programs, whose participants are primarily large business, do not require a plan similar to that mandated by the SBIR program. In response to this fact, one business questioned the equality of not making a similar requirement of large



businesses. One company questioned the need to reveal this sensitive information about the company in such a potentially public forum. In spite of the inequity, the remaining subjects highlighted the need for control over the tax-payer's money and acknowledged the plan was a way to safeguard against SBIR "mills." This fact alone tends to provide the necessary justification for the plan's fairness and realism.

Overall, the subjects responded favorably toward the SBIR program and its execution. They praised the opportunity to undertake "risky" research in the name of technological development. They accepted the bureaucracy that is inherent in Government business. Each acknowledged the need for commercialization as a way of directing research towards ends that provide foreseeable economic impact. Also, each recognized the benefits of preparing the commercialization plans. Finally, each subject is aware of the potential for dependence and has developed strategies within their businesses to prevent these conditions. This feedback, along with the following recommendations, will help improve the SBIR program.

### **Recommendations**

The small business participants in the survey have had enough experience to provide valuable insight into the

effectiveness of the program. As a result, the subjects also made recommendations regarding how the program can be improved. These recommendations focused on several areas, including bureaucracy, the innovation, commercialization, and the commercialization plan that has been mandated by recent changes in the program. Policy-makers should pay careful attention to these recommendations because they directly address the efficacy of the program. Previous research addressed effectiveness from the Government's point of view. This research expresses the perceptions of the participants. For the program to remain viable as a means of promoting small business innovation, it must meet the needs of the participants and encourage their participation. This participation leads to an increase in the pool of innovations and subsequently increases in the benefit enjoyed by the industrial base and the economy at large.

One recommendation suggests that the agencies generalize specifications and statements of work to allow maximum opportunity for the business to design the solution. Too much directive language forces the business to pursue a specific angle or technology in developing a solution. Broader performance specifications will facilitate innovation to the maximum extent possible. Scientists will be free to undertake new approaches when solving problems. Further, the Government benefits because it is given

solutions which tend to go beyond current technology and its previous applications.

Another area of improvement focuses on the approval process. Most subjects believe that the program would be improved if the Government would make the award process less cumbersome and more timely. One subject suggested that the Phase I and Phase II proposals could be considered at the same time. Another subject suggested that "pure" innovative solutions be considered separately from the commercialization ideas. Yet another subject suggested that only a description of outcomes be solicited. Issuing performance-based specifications allows the business, who has a greater knowledge of the industry, to decide how to best address the problem.

In the age of increased information transfer, the subjects indicated a benefit could be gained from sharing specific information between participants. Beneficial partnerships could be formed and less duplication of research effort achieved if the industry was informed, generally, about the activities undertaken by its members. Further, the Government could compile and maintain a living document that enumerates the technological needs of its agencies.

Another area of information transfer included providing support to the businesses in preparing solicitations. The

complex nature of Government contracting requires specialized knowledge to understand the requirements and how to fulfill them. Conferences can be held to clarify needs and goals. Presenting a single face to each potential contractors may limit the number of protests and inquiries. Better written proposals would also improve approval times and reduce the number of clarification questions asked after proposal receipt.

The last process-related recommendation addressed program oversight. To limit the number of businesses who may become SBIR "mills," records should be kept and consideration given to businesses who convert technological developments into useable products or services. Unrealized value is greatest when only ideas are generated. The legislation seeks tangible results from the execution of the program, not "wishful thinking."

Innovation is the cornerstone of the SBIR program. Recommendations related to innovation suggested innovators be given more discretion in pursuing streams of research. Scientists appreciate the advantage of uninhibited technological brainstorming, while business people tend to focus on financial bottom lines. A middle ground should be reached which allows scientists the freedom to use their expertise to develop useable end items. As evident in the creation of the SBIR program, society and the economy should

be able to benefit from both aspects of technology development. The process may be long, but the results of this study suggest that benefits are realized by all those involved.

Recommendations also focused on the increased emphasis in commercialization and the requirement to provide a commercialization plan. Each subject acknowledged the need and benefit of commercializing. However, its views vary on how this aspect of the program should be communicated. Timing is the major issue. One business recommended the timing be sooner than currently implemented, while another considered the timing premature. There was no consensus beyond the fact that all argued businesses would benefit if required to take an advanced look at the future of their business.

The responses given by the subjects illustrate the effectiveness of the program. Their testimony suggests that only minor process changes are needed. Their views were similar across product lines. A common awareness of how to operate in a business environment seemed to permeate the discussion. According to the survey of cases, the businesses who participate in the SBIR program share a commitment to being an independent business who provides services to the Government. The implications of this view are detailed in Chapter V.

## V. Conclusions

To remain effective, the Small Business Innovation Research (SBIR) program should respond to the changing needs and desires of the small business community it serves. Shifting policy emphasis without regard to its impact on the program's participants is likely to produce contrary results. The primary focus of this exploratory research was to identify the areas of concern for the small businesses. Their participation in the program provides the impetus for innovation, commercialization, and economic growth. The results suggest that Government involvement in technological advancement and Government sponsorship of small businesses are good. They also suggest that the Government review the program periodically to see if further efficiencies and effectiveness can be achieved.

This exploratory study is designed to provide a framework for future study. Therefore, findings and conclusions are preliminary. Analysis of the data collected indicated some need for continued research into the success of the SBIR program. This program must change with the conditions and circumstances in which it exists. It must also be responsive to its participants. First, the investigative questions and propositions are addressed. Next, recommendations for future study are made.

### Investigative Question #1

"Does the increased emphasis on commercialization limit the type of research activity that can be pursued through the SBIR program?" According to two of the small businesses who participated in the study, the emphasis on commercialization defines the nature of their business. It is intrinsic in their businesses to consider the commercial potential of their innovations. As a result, their scientists are encouraged to consider commercialization before undertaking a specific approach to the research. Consequently, the research approach is based on commercialization and not scientific discovery.

Other small business participants in the study suggested that increased emphasis on commercialization stifles their freedom to innovate. Ideas which do not readily suggest a commercial application are not pursued, while other ideas that have a potentially commercial application are undertaken. They also suggest that the preoccupation with commercialization can interfere with the Government's goals of developing innovative solutions to uniquely Governmental problems. Forcing scientists to find a commercially-viable solution for these "unique" requirements may make it impossible for innovators to develop responsive solutions.

It is apparent from the responses that two schools of thought remain. Some businesses do not see a problem with emphasizing commercialization. These businesses are encouraged by the Government's emphasis on commercialization and see potential access to other commercial markets through SBIR. On the other hand, the businesses who genuinely want to promote innovation consider the emphasis on commercialization a hindrance. These businesses want to use scientific processes to develop truly innovative solutions. They consider it a problem to require proof of an innovation before the innovation has a chance to be developed. As a result, they face compromising their creative intentions for the sake of winning SBIR contracts, and the Government mitigates the opportunity to find innovative solutions to its problems.

#### **Investigative Question #2**

"Does the increased emphasis on commercialization favor those contractors who can readily locate and obtain outside funding for potential research?" The results suggest that businesses who primarily seek commercial business have an advantage over businesses who do not. These businesses use SBIR funding as start-up money to cover initial research and development costs. Their primary intention is to sell their products to commercial industry. The fact that they



initially perform research utilizing Government resources is incidental to their process.

The research suggested that contractors who have already developed a technological idea which demonstrates commercial potential are more likely to win SBIR contracts because the evaluation criteria place emphasis on commercial potential. This favors the businesses who seek the SBIR program primarily as a means to reach other markets while providing some service to the Government. Additionally, the research suggested that the requirement to provide evidence of secondary funding is a source of bias. This evaluation criterion favors firms with research ideas that cater to the private markets because these contractors can readily locate outside investors. These firms also demonstrate a lesser need for the SBIR program than firms who promote basic research that do not attract as many investors.

The research demonstrated that emphasizing commercialization takes the focus away from the innovation and places it on the marketing activities. Businesses are indirectly encouraged to find investors first and creative and innovative solutions later. Businesses who heed this subtle message discover that their ability to sell the idea is more important than the innovative merit of the idea itself. "Blue-sky" innovative solutions only win over re-engineered existing technological innovation when the

marketing effort produces sufficient commercial investment commitment.

### **Investigative Question #3**

"Does the increased emphasis on commercialization and the requirement for a business plan penalize small business participants who have limited marketing capacity"? The research indicated that a variety of expertise is required to benefit from the new commercialization emphasis. Businesses who have limited staffs may be forced to expend considerable time and energy processing paperwork and responding to Government procedural requirements to increase their marketing efforts. The requirement to submit a commercialization business plan is cumbersome to small firms with limited marketing capacity. Consequently, they do not spend as much time making technological advancements.

Also, subject businesses considered the requirement to prepare a marketing plan to be somewhat unfair, given large business are not encumbered with a similar requirement. Small businesses, with limited resources, use their resources for technology development. Preparation of a business plan drains these scarce resources. The subjects acknowledged the benefits of preparing the plan; however, they also suggested other methods which could be used to encourage small businesses to seek alternative funding

sources while seeking innovative solutions. These recommendations were presented in Chapter IV.

#### **Investigative Question #4**

"Is the increased emphasis on commercialization and the requirement to utilize resources to develop a business plan and locate alternative funding sources counterproductive?" The study revealed that the subjects considered the emphasis on commercialization to promote the goals of the Act while the requirement to provide a marketing plan was another example of cumbersome bureaucracy. The need to consider the commercial potential for innovations is essential for businesses who plan to pursue activities in private industry. Without considering the needs of the commercial industry, their innovations may not have an application outside of the Government.

One the other hand, the requirement of provide a business plan is considered to be merely another procedural hindrance instituted by the Government. Its value is limited by the premature timing of the requirement. Since innovations have a long lead-time from conceptualization to deployment, the search for investors too early in the development stage is seen as merely an exercise of "filling the squares." This requirement for a business plan is contrary to the original intent of the Act because the Act

specifically mandates that the processes and procedures be designed to be less cumbersome.

### **Future Research**

Future research efforts should focus on one factor which attributes to the participation of small businesses in the SBIR program. Demographic information or a specific perception should be investigated to determine if there is any impact on participation, innovation, and commercialization. As research continues, issues should be combined to determine which combination of factors provides the greatest impact to small business participation, innovation, and commercialization.

Researchers should also continue to solicit the perspectives of the small business participants. Since the program exists to be utilized by small businesses, in support of improving the industrial base and the economy, their inputs are invaluable. They have proven to be most effective in developing technological innovation and will continue to provide this service for as long as they are encouraged to participate.

### **Conclusions**

The changes in the SBIR program have been gradual; and, for the most part, businesses have kept pace. They

recognized the need for a shift in the focus and are prepared to adjust to the requirements of the program. Improvements to the program require open dialogue with the participants to remain abreast of the impact associated with any changes. The businesses also indicated that the program should continue to seek to be less cumbersome and should provide more timely feedback. However, the businesses recognize that these situations are typically experienced whenever working with the Government. As a result, these situations provide little threat of businesses declining to participate in the program.

The goals of the program are somewhat contradictory and require a decision be made to determine which goal is most important prior to solicitation. Preferably, the users should decide whether innovation should win over commercialization potential, based on their needs. To gain the most benefit from the execution of the program, future solicitation should also be tailored to highlight the most important goal. Overall, the SBIR program is an effective program that encourages participation, innovation, and commercialization.

### Appendix A: Case Study Pattern Codes

PATTERN CODES	QUESTION	OPERATIONAL DEFINITION
SIZE-Less 10	D1	Size of Business (Less than 10): The data indicates that the business has less than 10 employees.
SIZE-10 TO 20	D1	Size of Business (10 to 20): the data indicates that the business has between 10 and 20 employees.
SIZE-20 plus	D1	Size of Business (More than 20): the data indicates that the business has more than 20 employees.
PRIM-Def	D2	Primary Product (Defense-related): The data indicates that the primary product of the business is defense- related.
PRIM-Nondef	D2	Primary Product (Non-defense- related): The data indicates that the primary product of the business is non-defense related.
PASTPART-None	D3	Past Participation (None): The data indicates no participation at any level.
PASTPART-P1	D3	Past Participation (Phase I): The data indicates participation at the Phase I level.
PASTPART-P2	D3	Past Participation (Phase II): The data indicates participation at the Phase II level.
PASTPART-P3	D3	Past Participation (Phase III): The data indicates participation at the Phase III level.
PASTPART-None	D3	Past Participation (Proposal): The data indicates participation at the Proposal level.
CURRPART-None	D4	Current Participation (None): The data indicates no participation at any level.
CURRPART-P1	D4	Current Participation (Phase I): The data indicates participation at the Phase I level.

PATTERN CODES	QUESTION	OPERATIONAL DEFINITION
CURRPART-P2	D4	Current Participation (Phase II): The data indicates participation at the Phase II level.
CURRPART-P3	D4	Current Participation (Phase III): The data indicates participation at the Phase III level.
CURRPART-Prop	D4	Current Participation (Proposal): The data indicates participation at the Proposal level.
NONSBIR-Yes	D5	Non-SBIR (Yes): The data indicates participation in non-SBIR technology development activities.
NONSBIR-No	D5	Non-SBIR (No): The data indicates no participation in non-SBIR technology development activities
CURRCOMM-Yes	D6	Currently Commercializing (Yes): The data indicates the business is seeking commercial applications for SBIR-developed technology.
CURRCOMM-No	D6	Currently Commercializing (No): The data indicates the business is not seeking commercial applications for SBIR-developed technology.
FUTRCOMM-Yes	D7	Future Commercializing (Yes): The data indicates the business is planning seeking commercial applications for SBIR-developed technology in the future.
FUTRCOMM-No	D7	Future Commercializing (No): The data indicates the business is not planning to seek commercial applications for SBIR-developed technology in the future.
INNOVATE-Aids	P1	Innovation (Aids): The data indicates the SBIR program aids the business's ability to innovate.
INNOVATE-Hind	P1	Innovation (Hinders): The data indicates the SBIR program hinders the business's ability to innovate.
AINFAC-Fund	P2	Aiding Innovation Factor (Funding): The data indicates that funding is a factor which affect the business's ability to innovate.

PATTERN CODES	QUESTION	OPERATIONAL DEFINITION
AINFAC-Info	P2	Aiding Innovation Factor (Information): The data indicates that information is a factor which affect the business's ability to innovate.
AINFAC-People	P2	Aiding Innovation Factor (People): The data indicates that people are a factor which affect the business's ability to innovate.
AINFAC-Credit	P2	Aiding Innovation Factor (Credibility): The data indicates that credibility is a factor which affect the business's ability to innovate.
AINFAC-Other	P2	Aiding Innovation Factor (Other): The data indicates that there are other factors which affect the business's ability to innovate.
HINFAC-Fund	P3	Hindering Innovation Factor (Funding): The data indicates that funding is a factor which affect the business's ability to innovate.
HINFAC-Info	P3	Hindering Innovation Factor (Information): The data indicates that information is a factor which affect the business's ability to innovate.
HINFAC-People	P3	Hindering Innovation Factor (People): The data indicates that people are a factor which affect the business's ability to innovate.
HINFAC-Credit	P3	Hindering Innovation Factor (Credibility): The data indicates that credibility is a factor which affect the business's ability to innovate.
HINFAC-Other	P3	Hindering Innovation Factor (Other): The data indicates that there are other factors which affect the business's ability to innovate.
USEFUL-Yes	P4	Useful (Yes): The data indicates that the businesses consider the SBIR program useful.



PATTERN CODES	QUESTION	OPERATIONAL DEFINITION
USEFUL-No	P4	Useful (No): The data indicates that the businesses do not consider the SBIR program useful.
GOVACTHIN-Yes	P5	Government Actions that Hinder (Yes): The data indicates there are specific Government actions that hinder the business's ability to innovate.
GOVACTHIN-No	P5	Government Actions that Hinder (No): The data indicates there are no specific Government actions that hinder the business's ability to innovate.
DEFIN-Helps	P6	Defense-encouraged Innovation (Helps): The data indicates defense-encouraged innovation helps innovation.
DEFIN-Hurts	P6	Defense-encouraged Innovation (Hurt): The data indicates defense-encouraged innovation hurts innovation.
PLANS-Help	P7	Commercialization Plans (Help): The data indicates requiring commercialization plan helps innovation.
PLANS-Hurt	P7	Commercialization Plans (Hurt): The data indicates requiring commercialization plans hurt innovation.
PLANSTOPS-Yes	P8	Commercialization Plans Stop (Yes): The data indicates requiring commercialization plans stop participation in SBIR programs.
PLANSTOPS-No	P8	Commercialization Plans Stop (No): The data indicates requiring commercialization plans do not stop participation in SBIR programs.
COMMBARR-Yes	P9	Commercialization Barrier (Yes): The data indicates commercialization is a barrier to development.
COMMBARR-No	P9	Commercialization Barrier (No): The data indicates commercialization is not a barrier to development.

PATTERN CODES	QUESTION	OPERATIONAL DEFINITION
CHANGES-Yes	P10	Changes (Yes): The data indicates that small businesses have recommendations to help the SBIR program meet its goals.
CHANGES-No	P10	Changes (No): The data indicates that small businesses have no recommendations to help the SBIR program meet its goals.
RELIANCE-Yes	P11	Reliance (Yes): The data indicates Government-sponsored research programs create reliance of the businesses for support.
RELIANCE-No	P11	Reliance (No): The data indicates Government-sponsored research programs do not create reliance of the businesses for support.
DEPEND-Yes	P11	Depend (Yes): The data indicates Government-sponsored research programs create dependence of the businesses for support.
DEPEND-No	P11	Depend (No): The data indicates Government-sponsored research programs do not create dependence of the businesses for support.
STRAT-Yes	P11	Strategy (Yes): The data indicates businesses use a strategy to counter reliance and dependence.
STRAT-No	P11	Strategy (No): The data indicates businesses do not use a strategy to counter reliance and dependence.
FAIR-Yes	P12	Fair (Yes): The data indicates the businesses consider the requirement for commercialization plan to be fair.
FAIR-No	P12	Fair (No): The data indicates the businesses do not consider the requirement for commercialization plan to be fair.
REALISTIC-Yes	P13	Realistic (Yes): The data indicates the businesses consider the requirement for commercialization plan to be realistic.
REALISTIC-No	P13	Realistic (No): The data indicates the businesses do not consider the requirement for commercialization plan to be realistic.

## Appendix B: Data Collection Questions

The following questions were used to guide the data collection process using telephone interviews. Interviews were conducted using open-ended question techniques. The questions were used to maintain research and participant focuses only.

### DEMOGRAPHIC QUESTIONS

- D1. What is your business size?
- D2. What primary products does your business develop?
- D3. Have you ever participated in the SBIR program?
- D4. Are you currently participating in any SBIR activities?
- D5. Are you actively involved in any technology development activities which are not currently being supported by SBIR?
- D6. Are you currently seeking commercial applications for SBIR developed technologies?
- D7. Do you plan to seek commercial uses for SBIR developed technologies?

### PERCEPTION QUESTIONS

- P1. Do you believe SBIR aids or hinders your ability to innovate? Why?
- P2. Identify specific factors which would aid your efforts to establish yourself as an innovator.
- P3. Identify specific factors which would hinder your effort to establish yourself as an innovator.
- P4. Are Government programs, like SBIR, useful? If so, specify how they have helped you.

- P5. Are there specific actions, on the part of the Government, which hinder your ability to innovate? If so, specify how.
- P6. To what degree does the requirement to develop commercial applications for defense-encouraged innovations, help or hurt your ability to innovate?
- P7. To what degree does the requirement to develop a commercial marketing plan, help or hurt your ability to innovate?
- P8. Has the requirement to provide a plan for commercialization stopped you from participating in Government-sponsored research? If so, what suggestions do you have to improve the situation?
- P9. Is the requirement for commercialization a significant barrier to further development of your business? If so, what suggestions do you have to improve the situation?
- P10. What changes could be made to the SBIR program and other similar programs that will both continue to encourage innovations and encourage the development of commercially viable innovations?
- P11. To what extent does the issue of reliance on Government-sponsored innovation influence your decision to seek Government-sponsored projects? Are you concerned that reliance may grow into dependence? If so, what strategies have you developed to counter this potential problem?
- P12. Do you believe the requirement for a commercialization plan is fair or unfair? Explain your view.
- P13. Do you believe the requirement for a commercialization plan is realistic? Explain your view.
- P14. If you had the ability to influence policy in this area, what changes would you make?
- P15. If you had the ability to influence policy in this area, what changes would you not make?

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Captain Thorpe entered the Air Force Institute of Technology at Wright-Patterson AFB, Ohio, in May 1995. She was admitted into the Graduate School of Logistics and Acquisition Management. Upon completion of the program in September 1996, she received a Masters degree in Contracting Management. She was subsequently assigned to a classified contracting position within the Department of the Air Force.

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13. ABSTRACT (Maximum 200 words)

This research explored the small business's perceived ability to provide goods and services to the Department of Defense through the Small Business Innovation Research (SBIR) program. The research was sparked by the enactment of Public Law 102-564, which increased the emphasis in commercialization as a basis for contract award and required a business plan to demonstrate commercial potential and third-party funding commitments. Five SBIR participants in the acquisition of Air Force research and developments innovation, were investigated through case-study methodology. The research concluded that although the defense industries recognized the cumbersome nature of government procurement, they are eager to provide recommendations that may enhance the effectiveness of the program. The research findings also suggested that the Government periodically solicit the perceptions of small business participants prior to making policy changes to ensure the impact of those changes is not contrary to the intent of the program. Finally, the research uncovered issues that impact small business participation in the program. Additional research into these issues may further improve the efficacy of the SBIR program which promotes technology transfer through the use of small businesses.

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